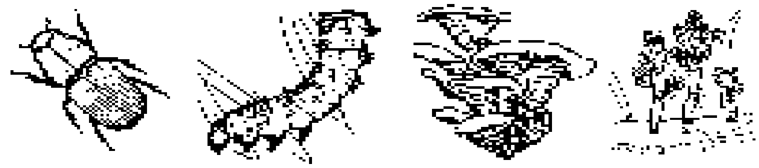
Forest Health Protection



Report 01-7 July 2001

EVALUATION OF BLISTER RUST IN WHITEBARK PINE

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On August 29-30, 2000 a group of Forest Health Protection and Rocky Mountain Research Station (RMRS) staff visited whitebark pine stands near Pyramid Pass and Roman Nose Lakes, Bonners Ferry Ranger District (RD), Idaho Panhandle National Forests (IPNFs). The purpose of the trip was to look at the impacts of white pine blister rust and mountain pine beetle on whitebark pine and discuss management options and related research needs. Participants included Sandy Kegley, Jim Byler, and John Schwandt from the Coeur d'Alene FHP field office, and Geral McDonald, Dennis Ferguson, Ned Klopfenstein and Ray Hoff (retired/volunteer) from the RMRS Forestry Sciences Lab in Moscow, Idaho in addition to Det Vogler (Research Associate with Pacific Southwest Research Station, Institute of Forest Genetics). The research scientists are all involved with or planning work on blister rust or whitebark pine.

This report documents the groups' observations and summarizes our discussions.

AREA DESCRIPTION

We visited two areas that were selected to provide readily accessible opportunities to look at a mature stand as well as a newly regenerating stand. Surveys in this and other nearby stands have been made since this trip to better describe conditions and this data will be summarized in a future report.

Whitebark pines are located in mixed stands with varying amounts of subalpine fir, Engelmann spruce and lodgepole pine along the tops of several ridges in the Selkirk Mountains west of Bonners Ferry, Idaho (figure 1). Although whitebark pines occur along the entire Selkirk Range above 5,000 feet in elevation, the largest mature stands are on Farnham, Russell, and Cascade Ridges that are bounded by Myrtle Creek on the south and Long Canyon on the north. The stand with the easiest access is on Farnham Ridge which is accessed via Pyramid Pass Trail from Trout Creek.

The whitebark pines around Roman Nose Lakes are primarily young trees that became established following the Sundance burn of 1967 or are scattered older remnants that the fire missed. However, most of the regeneration (probably over 90%) is either subalpine fir, spruce, western white pine, western larch, or lodgepole pine, so it is not likely that this area will become much of a whitebark pine stand without some sort of natural disturbance or human intervention.

In our brief field visit, it appeared that 90-99% of the mature whitebark pines were infected with white pine blister rust (based on "flagging," dead tops and dead branches observed). The blister rust pathogen was accidentally introduced into western North America early in the twentieth century and into Idaho in the 1930's. Since then, it has greatly impacted whitebark and other white pines so that only a few stands remain in north Idaho. We looked at several hundred mature whitebark pines in some areas and saw only a few uninfected (phenotypically resistant) whitebark, and we may have missed cankers in some of these.

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Figure 1. Stands of mixed whitebark pine along Russell Ridge in the Selkirks.

FOREST HEALTH OBSERVATIONS

The whitebark pine stands in the Bonners Ferry RD are some of the only remaining stands in north Idaho where this species is dominant. Over the last 10 years, annual aerial surveys have recorded varying amounts of mountain pine beetle mortality in the overstory trees. They documented a small outbreak of MPB in 1995 and a large outbreak in 1999 that continued into 2000. These dramatic losses prompted concerns that some of these stands might be completely lost due to bark beetles and white pine blister rust.

Preliminary ground surveys have confirmed very high levels of mountain pine beetle activity for the last 2 years. The results of these surveys will be the subject of a follow-up paper once the surveys and analysis are complete.

Infections in regeneration varied widely. Just below Roman Nose Lake where western white pine grows intermixed with whitebark pine, we conducted a brief survey to compare blister rust infection levels on western white pine regeneration to infection levels on whitebark pine regeneration. Prior artificial inoculation work found that whitebark pine was 45 times as susceptible as western white pine. However, we did not find nearly as dramatic a difference between infection levels on the two species in this area where they were intermingled. Both species were heavily impacted (>75%) and whitebark had only a few more cankers than western white pine.

We know that prior to the arrival of blister rust in the early 1920's, mountain pine beetle played a key role in recycling whitebark pine stands. Some stands may have burned before bark beetles caused much mortality, but many others probably burned as a result of the dead trees and slash created by the bark beetles. We can still find evidence of some of these mountain pine beetle outbreaks in the "gray ghost" forests of dead whitebark pine in some areas that have stood for many years. Some of these "gray ghosts" were observed in all the stands visited, and there were many such trees along the ridge to the east of Pyramid Pass. As the whitebark pine died, they were replaced by subalpine fir, spruce or lodgepole pine which appear to make up over 90% of the understory trees. Whitebark pine regeneration was rare and usually associated with natural openings such as rock outcroppings.

There is no evidence that bark beetles will preferentially attack blister rust infected trees. They didn't need it historically, and we found mountain

pine beetle attacks in trees with healthy crowns next to severely rust infected trees that were not attacked, and vice versa, so there appears to be no clear relationship between blister rust infection and mountain pine beetle attacks. However, it is likely that the bark beetle populations historically built up due to an overall decline in stand vigor or some sort of stand stress. And it is possible that widespread rust infection could produce similar effects in stands which might ordinarily have escaped beetle outbreaks for a while longer. Unfortunately, it is difficult, if not impossible, to determine if this is currently the case.

We also know that whitebark pine is a fire-dependant species that needs large openings to reproduce successfully, and that regeneration is established almost exclusively by the Clark's nutcracker. These birds aggressively excavate the seed from cones as they mature in the tops of mature trees, and will then fly long distances to cache thousands of seeds; especially in openings created by fires.

Other Forest Health Observations

We found one large spruce tree with spruce beetle pupae near the Pyramid Pass trailhead. The adults will emerge next spring to attack green or freshly down spruce. There is enough large spruce in the lower portion of this stand that it might be possible to sustain a spruce beetle outbreak, but a spruce beetle outbreak is unlikely because current beetle population levels are very low.

Adjacent stands with a high proportion of subalpine fir have scattered mortality caused by a combination of the western balsam bark beetle and root diseases that has been occurring for many years.

In one small area, we observed some defoliation in understory subalpine fir and Engelmann spruce. This was probably caused by the hemlock looper that occasionally causes this type of defoliation, but rarely results in mortality.

MANAGEMENT ALTERNATIVES

Whitebark pine and blister rust management were discussed at length. Many obstacles must be overcome if whitebark pine is to be maintained or restored as a viable host type over the long term. The loss of older stands to blister rust and endemic bark beetle populations has been accelerated by the current bark beetle outbreak. Blister rust kills nearly all naturally regenerated whitebark pine and in contrast to western white pine, which has been bred to improve natural genetic resistance to the rust, no rust resistant whitebark pine planting stock is available. However, field observations and preliminary research indicates that similar resistance may occur in whitebark pine.

Any form of management will be difficult and expensive because most whitebark pine occurs in poorly accessible mountainous terrain. Yet whitebark pine is a key species in healthy ecosystems of high-elevation forests, and there is considerable interest in its conservation and restoration. Without intervention, its future is bleak, not only in north Idaho, but across much of its range in the northern Rocky Mountains. We need to explore ways to conserve some of the current stands and either create openings that can be regenerated naturally by Clark's nutcrackers or plant seedlings to restore young whitebark pine stands.

Maintaining Current Stands

In spite of the current mortality there are still at least some mature whitebark pine that are not yet attacked by the mountain pine beetle. (This varied from about 17% in the Pyramid Pass stand to around 50% in the Russell Mountain and Burton Ridge stands.)

It may not be feasible to maintain the current stands given the mountain pine beetle outbreak. But in areas with low MPB populations, thinning the stand might lower the risk of attack and theoretically increase the numbers of pines and stands that will survive the beetle outbreak. Thinning to reduce density is an important tool for controlling losses from many bark beetles, and since MPB responds to stand density, thinning should probably work in whitebark pine. In lodgepole pine and ponderosa pine stands, we recommend thinning to 80-100 square feet of basal area. Although we don't know how low the basal area needs to be to make a whitebark pine stand unattractive to mountain pine beetle, if the other species (subalpine fir, spruce and lodgepole pine) were thinned from these stands, the basal area might drop below this level in at least some areas. If we are looking for ways to thin existing stands,

(and create fuels to carry underburns), a novel approach might be to encourage the levels of natural mortality in other species such as spruce and subalpine fir. Baiting green trees with attractants could enhance current western balsam bark beetle and spruce beetle populations which would likely result in additional mortality of these species. However, mortality in these other species due to additional bark beetle activity would be hard to predict, and would likely result in scattered pockets of mortality which might not be exactly where desired. The intensity and longevity of the additional mortality would also be hard to predict.

However, it is unlikely that we could initiate either of these thinning methods quickly enough to have much impact on the current mountain pine beetle outbreak.

We could use insecticide sprays to protect individual large whitebark pine from bark beetle attacks. Insecticides have been used to prevent bark beetle attacks in high-value areas such as campgrounds with other tree species with very good success. While this might be a good way to prevent MPB from attacking a few phenotypically resistant whitebark pine, it would be difficult and expensive to implement. Protective sprays may not be needed if there are smaller cone-bearing trees nearby that are also phenotypically resistant. Mountain pine beetle does not usually attack trees smaller than 6-8 inches in diameter. There were several smaller trees meeting this condition in the Pyramid Pass stand, but there were very few trees of this size in stands on the other ridges that we examined.

It may also be possible to protect individual trees or small tree groups by using newly developed semiochemical “anti-aggregants” to prevent attacks. A small study to test this hypothesis will be tried in this area in 2001.

Regenerating New Stands

Whitebark pine can best be regenerated by burning an area that has a ready supply of cone-bearing trees nearby to provide the Clark’s nutcrackers abundant opportunities to plant the seed. This assumes that there are enough cone bearing trees and a satisfactory nutcracker population nearby. High levels of mortality from blister rust can be expected, but if blister rust is reducing cone crops by killing tops of susceptible trees, the proportion of resistant seed cached by nutcrackers should be increasing

We could also plant openings with nursery grown seedlings from phenotypically resistant trees that might have a greater chance of surviving blister rust.

Genetic Considerations

Rust resistance in whitebark pine has been demonstrated and we can find individual trees with no infection in areas with very high levels of rust infection. This suggests that resistance genes may be well distributed, although in relatively low numbers.

The group felt that if 10% or more of the mature whitebark pine in a stand were uninfected (and survived MPB outbreak), this would likely be a sufficient number to maintain the gene pool. However, if the dead branches and flags we observed are an indication of blister rust infections, most stands appeared to have at least 90% infection and some stands had less than 1% uninfected mature trees, and some of these were being attacked by mountain pine beetle. (Fortunately, some of the regeneration samples were not as dismal; they varied from 100% infection to around 50%.)

Since at least 17% of the mature whitebark are currently unattacked in the Pyramid Pass area, the MPB outbreak doesn’t yet threaten the gene pool. However, it may interfere with natural selection for rust resistance if MPB attacks uninfected trees as readily as infected trees and the current outbreak kills many of the uninfected trees. It may also have an indirect effect, by killing so many trees that the Clark’s nutcrackers needed for replanting sites leave the area due to lack of large cone-bearing trees.

If the gene pool is at risk, we may need to start identifying phenotypically resistant trees, especially in areas with severe rust infection where selection pressure for resistance would be strongest. We may also want to consider locating phenotypically resistant trees in stands that are heavily attacked by mountain pine beetle. Ray Hoff has five small cone-bearing trees in each of three areas located, but the group felt this number should be increased

to 25-50 per drainage to provide an adequate gene pool.

It would be helpful if we could use some sort of DNA testing to determine the real resistance of these trees, but the technology and logistics of this is several years away, especially since we have yet to determine what sorts of resistance mechanisms might be present in whitebark pine and what genes might be involved in their control.

Identifying Uninfected (Phenotypically Rust Resistant) Trees:

Where possible, we might want to concentrate our efforts on locating smaller diameter (<10 inches) phenotypically resistant cone-bearing trees because they are not yet big enough to be a target for the mountain pine beetle. Smaller trees may actually be well over 70 years old, so they would have been exposed to the rust as long as the larger trees which may be more than 300 years old. Since blister rust didn't arrive until the mid 1920's, there is no reason to expect the smaller trees would be any more likely to have escaped rust infection than the larger trees.

It is also easier to check smaller trees for rust infections than larger trees, so it less likely to miss blister rust infections on small trees. Many trees had older dead branches in their crowns, and these might not all be due to blister rust. There are several small insects that can cause this type of damage as well as physical injuries from wind and snow, so positive identification of rust infection in large trees could be very difficult.

However, if the smaller trees are simply suppressed trees that are as old as the larger trees, there is some legitimate concern that concentrating seed collection efforts on these small (but old) trees would be a big step backwards genetically, as we might be inadvertently selecting for “slow-growth” genes.

Seed collection

If we don't have suitable planting sites, we may want to wait to collect seeds, especially since seeds in storage tend to lose viability rapidly. We would like to time seed collection with burning for site prep, but good cone crops and opportunities to burn may not occur in the proper sequence. We may also need to cage the cones to prevent harvesting by the Clark's nutcrackers and ensure seeds have an opportunity to ripen satisfactorily. The logistics of collecting cones can be very difficult, especially if additional trips are needed to cage the cones. Some trees might require ladders or other more advanced climbing equipment to reach the cones. Hiking long distances with this gear might not be possible.

Research Needs (Unanswered Questions)

During our discussions, it became apparent that there are many questions about blister rust in whitebark pine that need to be answered to give us a better understanding of the situation and how to best handle it. A summary of priority needs follows.

We need a better understanding of the genetic resistance in whitebark pine. Are there different resistance mechanisms present? Are they multi-genic? And how much resistance is present in current whitebark pine populations?

We need to understand variability in blister rust. Are there different races that have developed in different areas on different white pine species (including limber and bristlecone pines as well as whitebark and western white pine)? Knowledge of rust variation in different white pine species in different areas would provide a much-needed perspective for the development of breeding strategies.

Little is known about the epidemiology of rust in whitebark pine, i.e., where sources of ribes occur, how far spores are transported, how frequently major infection years occur.

There are many questions about the rust infection process that are linked to weather or microenvironment. We had considerable discussion about the utility of a weather model, should one be developed.

We also need more research and technology development on prescribed fire. Burning windows are so narrow some years that burning is never done. We need a way to use fire reliably, so that if we go to the effort of creating extra fuels to carry a fire (through thinning/slashing), we will be able to use it in a timely manner.

We may also need additional information about the silvics of growing whitebark pine (in nurseries) and

the relationship with Clark's nutcrackers, i.e., what is the minimum number of live trees needed to sustain a viable nutcracker population, what size of openings are preferred, etc.

There was a lot of discussion regarding the need for long-term studies and monitoring to document the status of both blister rust and MPB on whitebark pine and results of treatments. This information should be reported in referenced journals, and especially interdisciplinary publications. However, the general public does not read these journals, so information should also be in publications with broader appeal as well. Although there is much we don't know, we do have enough information to be able to provide some scientifically sound information regarding the current situation and future trends. Information on treatment effects could be of real importance to forest managers who are trying to maintain or enhance the health of the whitebark pine ecosystem.

Summary and Conclusions

Whitebark pine management presents many challenges, but without action, whitebark pine populations will continue to decline and opportunities to influence losses will become even more limited. Some actions, summarized below, appear to be appropriate steps that should be taken soon.

We need to continue to monitor the current mountain pine beetle outbreak and document the combined losses from both bark beetles and white pine blister rust. Additional stands with major components of whitebark pine need to be surveyed. If there are stands with considerable large whitebark but low MPB mortality, there may be time to implement some thinning to reduce MPB risk.

If losses from MPB threaten entire stands, insecticides or pheromones might be applied to try to protect individual phenotypically resistant mature trees.

We also need to start identifying (and locating with GPS) phenotypically resistant trees for future seed collection. We will need to monitor cone crops, so that seed collection can be most efficient.

It also appears to be prudent to begin field treatments that might help restore young whitebark pines, and to monitor results so that corrections can be made in future treatments. For example, we need to make new openings to encourage natural regeneration while we still have a seed source. The Bonners Ferry Ranger District is already initiating plans for some trials using prescribed fire. Even though natural regeneration is at risk to blister rust, current levels of uninfected seedlings in some areas may indicate rust resistance and provide potential for increased natural selection in the future.

We need to find ways to promote additional research on the unanswered questions listed above.

Plans and Progress

Although resources are limited, several actions are underway, and there are plans for projects in several of the areas mentioned above. For example, the Bonners Ferry RD is currently planning some controlled burns in whitebark areas, and FHP is conducting a pheromone test to see if MPB can be prevented from attacking trees. Permanent plots established in several young whitebark pine stands 5-6 years ago will be remeasured this year to obtain information regarding rust infection and intensification. In addition, the Regional genetics program has initiated plus tree selection for phenotypically resistant whitebark pine across Regions 1 and 4.

These observations and comments have been presented to help focus attention on additional needs regarding blister rust in whitebark pine. All the participants on this trip will continue to look for opportunities to solve some of the questions raised, and we hope that distribution of this information will foster additional support and action for improving the future of whitebark pine.